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A New Mole from Uotsuri-jima, the Ryukyu Islands

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Abstract. A new genus, with a new species, of the talpine mole is described from the island of Uotsuri-jima in the Senkaku Islands, the Ryukyu Islands, under the name of *Nesoscaptor uchidai*. This species retains the dental formula of I3/2+C1/1+Pm3/3+M3/3=38, which consists of one fewer pair of teeth in the lower incisors than in *Scaptochirus* with 40 teeth. The skull has very short and broad rostrum, broad maxillary portion, and very large molars all of which are also characteristic to *Scaptochirus*. Except for the dental and skull characters probably induced by the reduction of teeth, the other characters such as the feature of tympanic bulla, the ear bones consisting of malleus with a broad and long triangular cavum lamina and of short incus, and the pelvic girdle with two pairs of dorsal foramina are principally common to those of *Euroscaptor* and *Mogera*. Thus the new species is a composite of some other talpine moles. Retaining two cusps on the last lower premolar is a remarkable character which has never been found in any of the other talpine genera.

Key words: *Nesoscaptor uchidai*; Mole; New genus; New species; Ryukyu Islands.

In Asia there occur nine genera and about 16 species of talpid moles which consist of various types ranging from very primitive shrew-like moles, *Uropsilus*, to advanced true moles, *Mogera*. Consequently, Asia, especially the Far East, is regarded as a center of talpid radiation (Abe, 1988). The classification of the talpid moles and their phylogenetic relationships in Asia, however, have not yet been sufficiently surveyed.

In 1979 the junior authors had an opportunity to visit the Senkaku Islands in the Ryukyu Islands as members of the Senkaku Islands Survey Team sponsored by Okinawa Development Agency. During this survey, they obtained a talpine mole specimen in Uotsuri-jima, the largest island in the Senkaku Islands. The senior author taxonomically examined the specimen comparing with many other specimens of talpine genera deposited in the British Museum (Natural History) in London, the American Museum of Natural History in New York, and Laboratory of Applied Zoology, Faculty of Agriculture, Hokkaido University, and concluded that it is a new species which does not belong to any existing genus and might have been derived from Miocene moles. The following is the description of the new mole.

Nesoscaptor gen. nov.

Type species: *Nesoscaptor uchidai*, sp. nov.
Included species: The type species only.
Distribution: The island of Uotsuri-jima in the Senkaku Islands, the Ryukyu Islands.
Etymology: *Nesoscaptor* (Gr.)=nesos (island)+scaptor (digger).
Diagnosis: The following combination of characters sets *Nesoscaptor* apart from any other known genera of Talpinae (Fig. 1; Fig. 2a – k; Fig. 3a – c, g – h, l): 1) small body size; 2) relatively small manus; 3) relatively short tail; 4) nostrils directed outward; 5) naked portion on the upper side of muzzle rather rectangular in outline; 6) rostrum of skull very short, broad and markedly bent downward; 7) interorbital portion broad and long; 8) palatal portion very broad; 9) upper incisor row projected forward; 10) upper premolars three, with a smallest first; 11) upper molars very large, and the row length clearly exceeds the distance from canine to last premolar; 12) tympanic bulla large, roundish, and flat; the position as usual, the posterior tip extending backward beyond the line connecting mastoid processes; 13) lower incisor-like teeth three and large; 14) lower premolars three, with a first caniniform tooth, a smallest second, and a two-cusped third; 15) lower molars large; the row length exceeds the distance between first lower incisor and last lower premolar; 16) processus longus of incus relatively short; cavum lamina of malleus broad and long triangular; capitulum mallei not of a globular formation; 17) humerus slender; 18) pelvic girdle with two pairs of dorsal foramina; 19) sacrum consisting of seven vertebrae.
Remarks: The genus *Nesoscaptor* was established mainly on the basis of the dental formula, the third lower premolars with two central cusps, and the feature of tympanic bulla.

Regarding the dentition of talpine moles, abnormality of tooth number has been often observed and discussed (Thomas, 1881, 1910; Miller, 1940; Imaizumi, 1955). The dentition with one less pair of upper premolars in *Parascaptor*

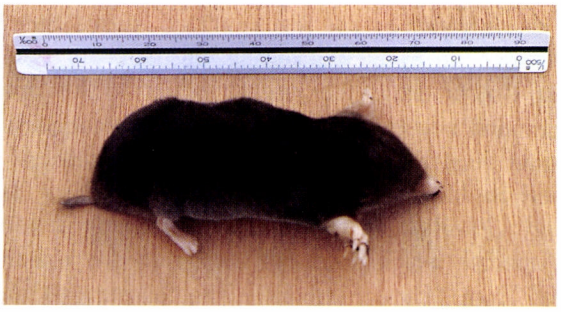

Fig. 1. The type specimen of *Nesoscaptor uchidai* at the time of capture. The scale is 15 cm.

and that with one less pair of premolars both above and below in *Scaptochirus*, compared with *Euroscaptor* and *Talpa* with a full number (44) of teeth, have

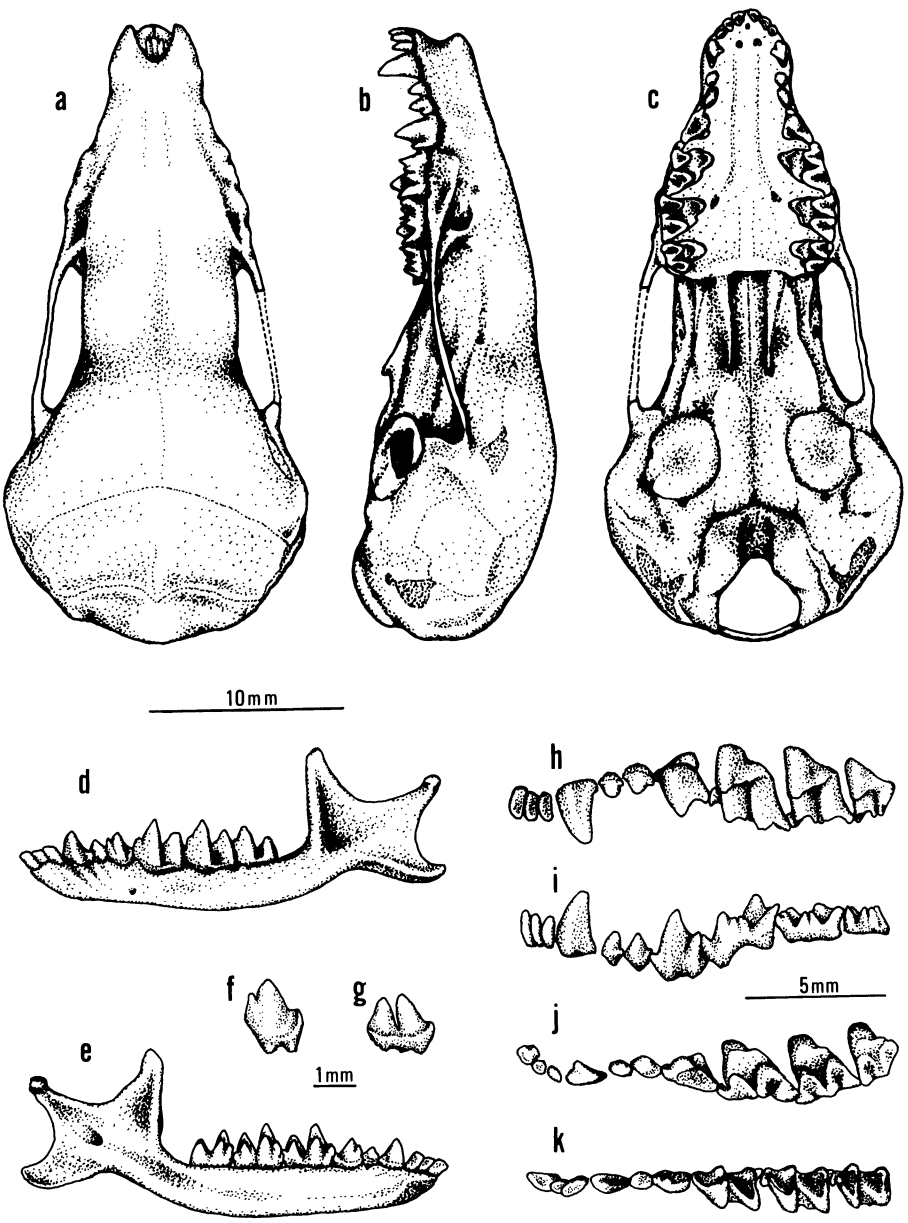

Fig. 2. Skull, mandible, and teeth of *Nesoscaptor uchidai*. a, the dorsal view of skull ; b, the left side ; c, the ventral view ; d, the labial side of left mandible ; e, the lingual side of left mandible ; f, the labial side of the last, left lower premolar ; g, the lingual side of the last, right lower premolar ; h, the lingual side of the right upper tooth row ; i, the labial side of the right upper tooth row ; j, the crown view of the right upper tooth row ; k, the crown view of the left lower tooth row.

been ascertained through the discussion, and now they are recognized as valid genera (Honacki *et al.*, 1982; Corbet & Hill, 1986).

Before the identification of the present new genus, we examined 458 mole specimens consisting of 265 of *Mogera robusta* (subspp. *kobeae* and *coreana*) from Japan and Korea, 163 of *M. wogura* from Japan, and 30 of *M. tokudae* from Japan for the dental abnormality. The principal dental formula of the genus *Mogera* is I3/2+C1/1+Pm4/4+M3/3=42. Although we found "abnormal denti-

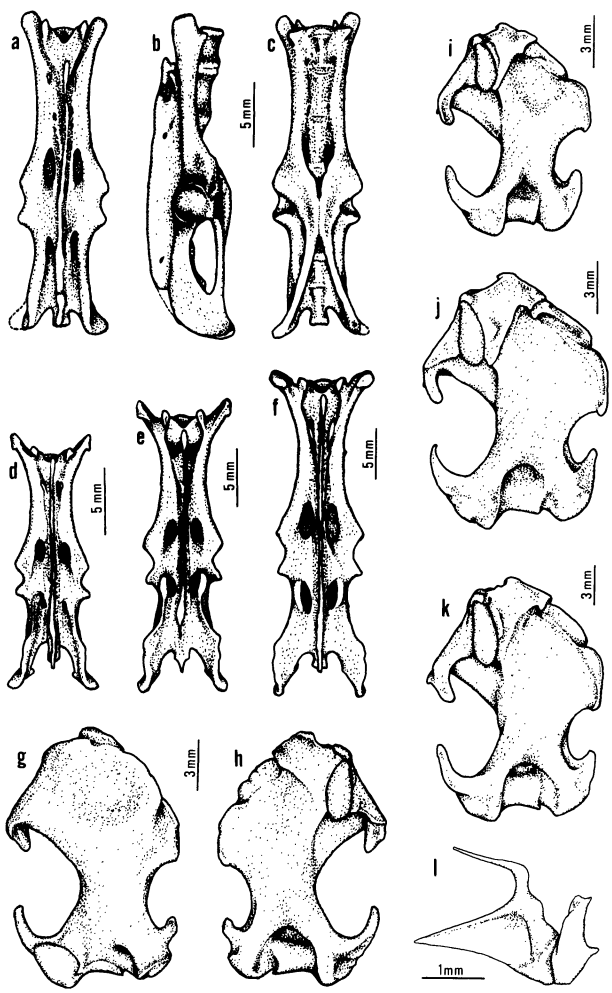

Fig. 3. Pelvic girdle, humerus, and ear bones. a – c, the pelvic girdle of *Nesoscaptor uchidai*, a, the dorsal side, b, the right side, c, the ventral side ; d – f, the dorsal view of pelvic girdle of *Euroscaptor mizura*, *Mogera wogura*, and *M. robusta kobeae*, respectively ; g – k, humerus ; g, the anterior view and h, the posterior view of the right humerus of *N. uchidai*, i, the posterior view of the left of *E. mizura*, j, the posterior view of the left of *M. wogura*, and k, the posterior view of the left of *M. robusta kobeae* ; l, the dorsal view of the left malleus (left) and incus (right) of *N. uchidai*.

tion" in 79 individuals in total, most of them were accidental loss due to break or falling off after the eruption as estimated from the broad dental space at the proper site, abnormal arrangement of the neighboring teeth, and sockets or roots remained in place. Probable real abnormality was found only in 13 individuals (2.8%) in which seven had no smallest second upper premolar(s) (one side or both), one no third left upper premolar, one an excess pair of tiny upper premolars (four tiny unicuspid premolars and a large one each at right and left sides),

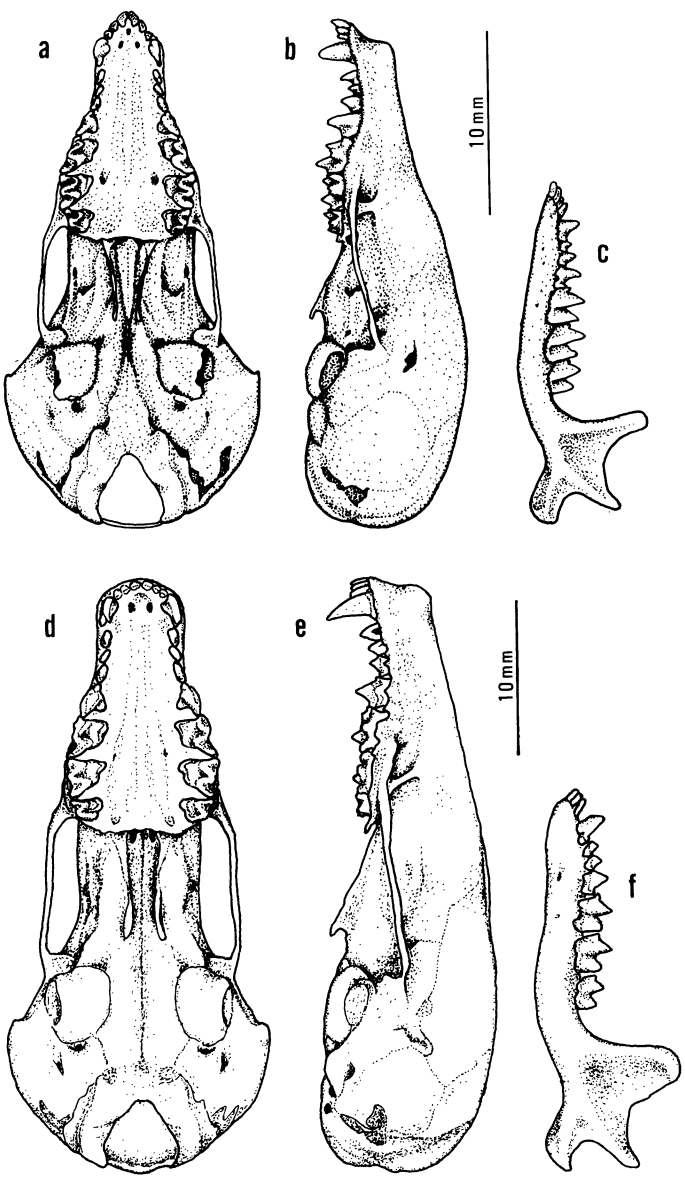

Fig. 4. Skull and mandible of *Euroscaptor mizura* (a – c) and *Mogera robusta kobeae* (d – f).

two no smallest second lower premolar, one the second and third lower premolars fused to a single tooth, and only one (0.2%) retained one less right lower incisor. Thus the dentition in *Mogera* spp. is slightly variable in the small premolars, but rather constant and especially so in incisors; no specimen with the same type of dentition as that of the new species was found in those examined.

In the present type specimen, tooth rows both above and below are well arranged and crowded. Molars and lower incisors are relatively large. All these characters suggest that the reduced dentition of the type specimen is not

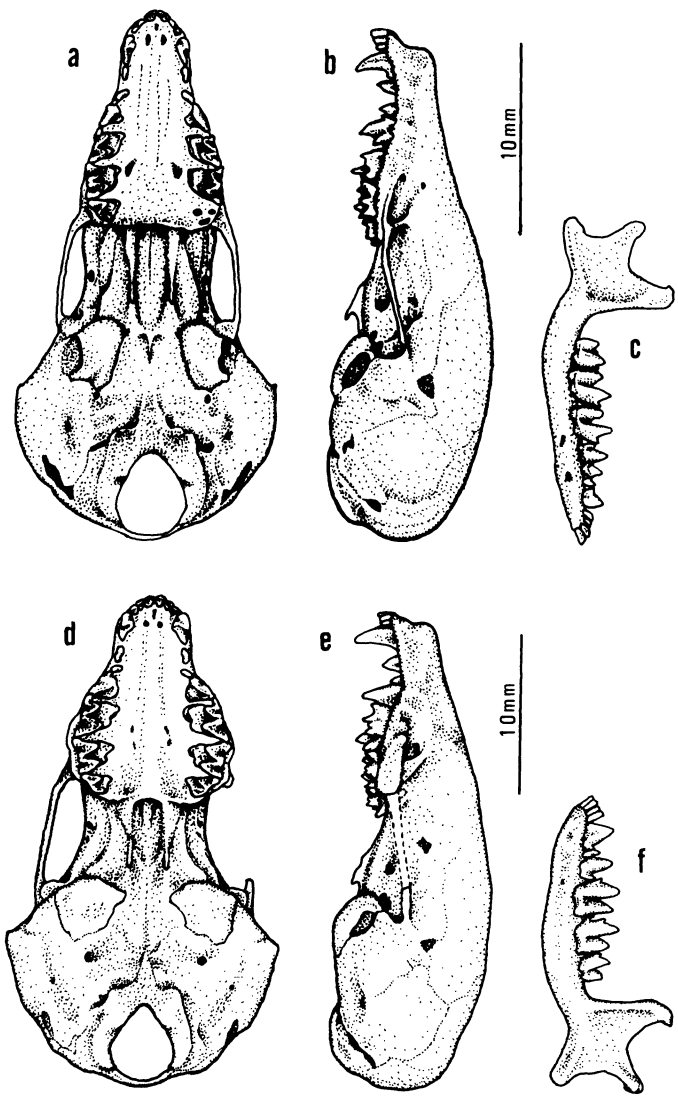

Fig. 5. Skull and mandible of *Parascaptor leucura* (BM 32 · 11 · 1 · 177) (a – c) and *Scaptochirus moschatus* (BM 10 · 3 · 13 · 1, type of *S. gilliesi*) (d – f).

of an individual abnormality but of a reliable feature of this species.

In *Nesoscaptor*, *Euroscaptor* except *E. micrura*, *Talpa*, and *Mogera*, the position of tympanic bulla is not shifted anteriorly, i.e. the posterior end extends posteriorly beyond the line connecting mastoid processes or, in some species of *Talpa*, it is situated at the line (Fig. 2c; Fig. 4a, d). Thus, *Nesoscaptor* is different in this character from *Parascaptor* and *Scaptochirus* with an anteriorly shifted tympanic bulla; the posterior end is situated at the line connecting mastoid processes or further anteriorly (Fig. 5a, d). The posterior end in the latter two genera is markedly lifted in lateral view, so that the angle formed by longitudinal axes of the skull and the tympanic bulla is greater than 20 degrees.

As a conclusion, the genus *Nesoscaptor* retains combined primitive, advanced, and new characters such as 1) reduced dentition which is an advanced apomorphic character for talpines and probably induced the large molars and the short rostrum as found in *Scaptochirus*, 2) less specialized, plesiomorphic large third molars as in the primitive genus *Euroscaptor*, 3) also less specialized feature of tympanic bulla which is common to those of *Euroscaptor*, *Talpa*, and *Mogera*, 4) two cusped third lower premolar which has never been found in talpine moles, 5) relatively long interorbital portion of skull found only in advanced species such as *Mogera* and some of *Talpa*, 6) slender, simple pelvic girdle with two pairs of the dorsal foramina rather similar to those of *Euroscaptor* and *Mogera*, but not to that of *Talpa* (Stroganov, 1948), and 7) long sacrum with seven vertebrae which are probably not found in other talpine genera (Stroganov, 1948; Yoshiyuki, 1986).

Nesoscaptor uchidai, sp. nov.
[Japanese name: Senkaku-mogura]

Holotype and type locality: The holotype is a young adult female collected by S. Shiraishi and S. Arai from a grassy field at the west coast of Uotsuri-jima in the Senkaku Islands, the Ryukyu Islands, on 2 June 1979. The specimen consists of a stuffed skin, cranium, mandible, and almost whole skeleton. The type is deposited in the Zoological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka, Japan.

Measurements: Humerus: length 14.60 mm, breadth 9.80 mm; length of pelvis 24.16 mm. Refer to Table 1 for others.

Referred specimen: The holotype only.

Distribution: Known only from the type locality.

Etymology: Specific name *uchidai* was dedicated to Professor Teru Aki Uchida, Kyushu University.

Diagnosis: Because *uchidai* is the only known species of *Nesoscaptor*, the generic and specific diagnoses are the same.

Description:

External character: Size small. General features as usual, except for relatively small manus and very short tail with ratios to the head and body length of 10.8 percent and 9.2 percent, respectively. Nostrils directed outward, median pad of

rhinarium protruding and separated from the lower transverse pad by a horizontal groove as in *Euroscaptor*. Dorso-posterior border of rhinarium strongly concave at middle (V-shaped). Naked portion on the upper side of muzzle rather rectangular in outline, although not clear as in *Mogera*, and with a longitudinal groove along the middle line.

Color of dorsal fur close to Dark Grayish Brown or Dusky Drab; slightly paler and Dusky Drab underside; throat and chest Hair Brown (color nomenclature after Ridgway, 1912). Tail and the back of hind foot covered with Drab colored long hairs; pencil hairs of the former about 8 mm long at the longest. Manus with a fringe of Drab colored stiff hairs.

Skull: When viewed from above, skull gradually tapering forward, not apparently constricted at the frontal part of last premolars. Mastoid processes inconspicuous. Rostrum markedly bent downward when viewed from side. Relative breadth of braincase and relative length of palatal portion as usual. The palatal portion, however, very broad; rostrum very short but broad; ratio of breadth across molars to palatal length (71.7%) and that of the length from last premolar to last molar to the length of upper tooth row (62.4%) exceed those in any other species of moles except *Scaptochirus*. In contrast to the short rostrum, molar row very long and the length clearly exceeds the distance from the anterior tip of canine to the posterior end of last premolar, a character which is also similar to that of *Scaptochirus*.

Upper incisor row well projected forward; this character resembles those of *Talpa*, *Euroscaptor*, *Parascaptor*, and most species of *Mogera*, but differs from those of *Scaptochirus* and the advanced taxon, *robusta*, of *Mogera*. There is a small space between canine and the following premolar; premolars well crowded. Interorbital portion relatively broad and long; the proportion (21.4%) of the distance from the posterior tip of palate to the anterior margin of tympanic bulla to the greatest length of skull relatively large, similar to those of advanced moles, *Mogera* spp., *Talpa romana*, and *T. altaica*. Tympanic bulla large, flat, and roundish; the position of bulla as usual, the anterior tip not extending forward beyond the anterior tip of the superior facet of mandibular fossa, and the posterior tip extends postward beyond the line connecting mastoid processes. Posterior portion of bulla not lifted, so that, when viewed from side, the angle made by longitudinal axes of skull and tympanic bulla small, less than 20 degrees (Fig. 2b). The characters of tympanic bulla resemble those of many other species except *Scaptochirus* and *Parascaptor*. Ear bones are of the type of *Euroscaptor* and *Mogera* and not of *Talpa* and *Parascaptor*: incus with a relatively short processus longus and small processus brevis; malleus with small and ill defined apophysis orbicularis; cavum lamina broad and long triangular; capitulum mallei not of a globular formation but only of a well developed thickening of articular surface (Fig. 3l).

Mandible and lower tooth row relatively long; especially the molar row very long, the length apparently exceeds the distance from first lower incisor to last lower premolar. Coronoid and angular processes of mandible slender and weak.

Teeth: Upper tooth row retains three pairs of premolars well crowded. Lower

tooth row also well crowded; it consists of three pairs of incisor-like teeth, a pair of canine-like teeth, two pairs of premolars and three pairs of molars. Reduction of tooth number in this species occurred probably due to the disappearance of the second upper premolar, which is smallest in premolars of many other mole species with the tooth, to that of the third (usually smallest) lower incisor, and to that of the second (usually smallest) lower premolar. Thus, the dental formula: I3/2+C1/1+Pm3/3+M3/3=38.

Last lower premolar has two clear central cusps, being one of the most prominent characteristics of the teeth of this species (Fig. 2f, g). Shape of other teeth as usual for talpine moles. Anterior upper premolar small, about half the size of the middle, and single rooted; the posterior much larger than the middle. Upper molars very large absolutely and relatively; the relative size comparable

Table 1. External and cranial measurements of seven species of talpine moles (in g or mm)

	Nesoscaptor uchidai Holotype	*Scaptochirus moschatus* ♂ BM 10·3·13·1, type of *gilliesi*	*Parascaptor leucura* BM 32·11·1·177	*Euroscaptor mizura* Av. of 4 individ.	*Talpa caeca* BM 14·5·5·2, type of *occidentalis*	*Talpa romana* BM 1·1·2·8 -(type)	*Mogera robusta kobeae* $\bar{x} \pm SD$ of 15 individ.*
Body weight	42.7			29.1			121.4 ±18.5
Head & body	129.9			104.3	102.0		161.8 ± 5.3
Tail	12.0			23.3	24.0		19.6 ± 1.8
Fore foot (s. u.)	14.0			15.3	19.9		22.1 ± 1.1
Width of fore foot	15.4			14.7	17.6		21.7 ± 1.4
Hind foot	16.0			15.0	19.9		21.4 ± 0.9
Greatest length of skull	31.82	30.19	27.43	27.60	31.12	36.58	39.27± 1.05
Condylobasal length	30.92	29.23	26.51	26.80	30.30	35.93	38.28± 1.05
Palatal length	12.50	12.54	11.36	11.17	13.03	16.07	15.55± 0.51
Rost. bread. at canines	4.52	4.68	3.73	3.63	3.95	5.33	5.46± 0.25
Breadth across molars	8.96	9.82	7.09	7.00	8.19	11.04	10.14± 0.34
Great. interorbit. bread.	7.62	8.04	6.99	7.06	7.42	8.14	8.45± 0.32
Zygomatic breadth	12.60	—	9.60	9.75	—	14.69	14.17± 0.55
Breadth of braincase	15.26	17.03	13.62	13.73	15.33	17.63	18.40± 0.69
Depth of braincase	9.66	—	—	8.14	—	—	11.72± 0.43
I^1-M^3	13.52	12.63	11.54	11.69	13.14	16.22	16.38± 0.47
C-M^3	11.74	11.41	10.04	10.34	11.55	14.34	15.10± 0.44
Last Pm-M^3	8.43	7.56	6.71	6.37	7.45	9.50	9.54± 0.24
Length of mandible	21.00	19.36	16.76	17.13	19.86	24.88	25.50± 0.81
I_1-M_3	12.91	12.16	10.73	11.02	12.26	15.34	15.30± 0.44

* A local population with large body size in Nagano Pref., Honshu, Japan.

to that of *Scaptochirus*, but differing from the latter in the larger third molar with a relatively large metacone so that it is less deformed from the usual molariform tooth (Fig. 2j). Parastyle of first upper molar well developed as in *Scaptochirus*. Three lower incisor-like teeth relatively large and well crowded; the largest first spatulate, and the smallest second and medium-sized third chisel-like. Lower unicuspid premolar small, about one-third the size of the succeeding premolar with two cusps and two roots, and single rooted. Lower molars very large, absolutely and relatively; the third also relatively large.

Other bones: Vertebrae retain a characteristic composition: 7 cervical, 14 thoracic, 5 lumbar, 7 sacral and 4 (+) caudal vertebrae; the number of sacral vertebrae is 5 (rarely 6) in *Euroscaptor* and 6 in *Mogera*; the 7 in the new species has never been found in the former two genera; the number of thoracic vertebrae same as that of *Mogera*, exceeding by one vertebra that in *Euroscaptor*.

Pelvic girdle retains two pairs of dorsal foramina as in *Euroscaptor* and *Mogera*; anterior foramina about three times larger than the size of posterior ones, the relation of which resembles that of *Euroscaptor* rather than that of *Mogera* (Fig. 3). When viewed from above, anterior part of ilium thick, short and weakly bent outward; fissure between ischia very shallow because of posteriorly extended long sacrum with an excess vertebra; posterior end of ischium bent outward. Innominate bone slender in lateral view, with a relatively broad posterior part of ischium.

Humerus as usual but apparently slightly more slender; the ratio of the breadth to the length 67.1 percent as compared with 73−74 percent in *Euroscaptor* and *Mogera*; the ratio of the former itself is similar to that of Scalopine fossil species, *Yanshuella primaeva*, of the uppermost Miocene or the lower Pliocene (Storch & Qiu, 1983), although the other characters of humerus are slightly different. Entepicondyle narrower; "scalopine ridge" weak, inconspicuous, and disappearing at the side of head.

Discussion

Taxonomic Remarks

In talpine moles, body and skull sizes are very variable within species according to habitat conditions; the size itself, therefore, is not a good taxonomic character, and the variation has often caused a severe confusion in taxonomy (Abe, 1967). The shape of skull is also variable both with advancing age and with local size variations. If the variations were taken into consideration, however, the shape (relative size of dimensions) is usually good enough for the diagnostic measure of taxonomy.

The holotype probably is about six months old or younger, judging from the unworn sharp teeth and the feature of bones. Marked forward-projection of the upper incisor row, the relatively broad interorbital portion, and the less conspicuous mastoid process of the type specimen are probably, at least to some extent, ascribed to the young age.

The lower last premolars of the type are quite different in shape between left and right jaws; the right tooth is larger than the left and retains two large similar sized cusps, the form of which is apparently aberrant. Most of the other important dental and skull characters, however, appear to be reliable and particular to this species.

Isolation and the Origin of New Species

The Ryukyu Islands are about 1,100 km long archipelagos ranging from the south-west end of the main Japanese Islands to the north-east of Taiwan. The Ryukyu area was repeatedly connected with and disconnected from the Chinese Continent and the main Japanese Islands during the Tertiary. Excepting the northern parts and the Senkaku area, the latest connection of the Ryukyu Islands with the Chinese Continent occurred in the early Quaternary; main parts of the Ryukyu Islands have been thereafter isolated as islands for more than one million years till now (Kizaki & Oshiro, 1980). Due to the isolation many characteristic relict species have retained their populations and differentiated to the present state in the Ryukyu Islands: the Amami rabbit *Pentalagus furnessi*, the Ryukyu long-tailed giant rat *Diplothrix legata*, the Ryukyu spiny rat *Tokudaia osimensis*, and the Iriomote cat *Mayailurus iriomotensis*. There also occur many endemic species of birds and reptiles in these islands.

The Senkaku Islands are located at longitude 123°28'−124°34' E and latitude 25°44'−25°56' N at the south-west end of the Ryukyu Islands, i.e. about 200 km north-east of Taiwan and about 300 km from the Chinese Continent (Fig. 6). The history of formation of the Senkaku Islands is basically different from that of

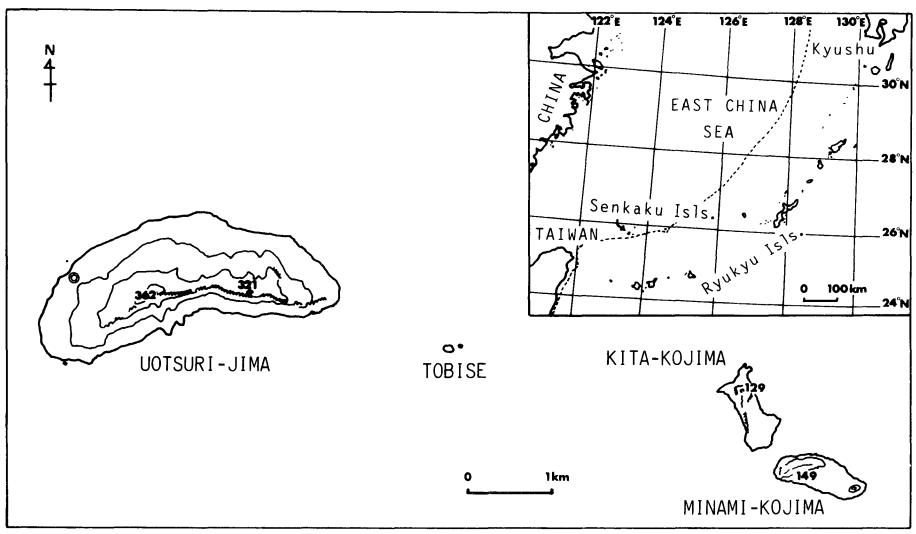

Fig. 6. Map of the main part of the Senkaku Islands. The double circle on Uotsuri-jima indicates the collecting site of the type specimen. *Inset.* Dotted line indicates the outer marginal line of the continental shelf with about 200 m depth.

the other Ryukyu islands. The former is located at the outer edge of continental shelf with a sea depth of about 200 m, and 1,000 to 2,000 m deep sea lies between the Senkaku and the Ryukyu proper. The Senkaku area was always a part of the Continent through the Miocene and also was connected with the other Ryukyu islands during the middle and late Miocene (Kizaki & Oshiro, 1980). The area, however, was disconnected from both the Continent and the other Ryukyu islands in the Pliocene and the isolation has been maintained for more than six million years, i.e. it kept the isolation even during the period when the middle and the other south Ryukyu islands were connected with the Continent in the early Quaternary (Kizaki & Oshiro, l.c.).

According to Professor K. Kizaki of Ryukyu University (pers. comm.) there are some uncertain problems concerning the isolation of the Senkaku Islands in the last glacial age (Würm) because of scarce information on the continental shelf surrounding the islands, and it is possible that the Continent was approached to or connected with the islands due to the retreat of the sea in this age. Nevertheless, since the mole in Uotsuri-jima is primitive in one part and highly differentiated in another part, the original mole might invade here in the Miocene and might have maintained the isolated island population for the longest period of years in the mammals of the Ryukyu Islands. Probable settlers in other areas, however, might have become extinct or evolved into some other taxa in the Continent. European Pliocene talpid species are closely related to the Recent species (Hutchison, 1974). If the present new genus is a derivative of Miocene or Pliocene talpids, the present finding indicates that a similar evolutionary event has occurred in Asia.

The Senkaku Islands consist of five islands and several reefs. Uotsuri-jima is the largest island, about 3.3 km long, 1.3 km wide, and 4 km^2 in area; a chain of ridges with two peaks of 362 m high Narahara-dake and 321 m high Byobu-dake is located on the south parts of the island; the south slopes of the ridges form a steep cliff (Fig. 6). The northern slope is covered with natural forests consisting of *Livistona chinensis* R. Br. var. *subglobosa* Becc., *Persea thunbergii* Kosterm., *Ficus microcarpa* L. f., *Arenga tremula* Becc. and many other tropical trees. One hundred and three families and 339 species of vascular plants have been recorded from the island of Uotsuri-jima (Niiro & Shinjo, 1980).

From 1900s through 1910s a dried bonito factory and a small cultivated field had been settled near the western beach. There are no houses at present and the housing area is covered with *Miscanthus sinensis* Anders. and other vegetations. The junior authors found mole burrows made in the shallow surface soil and collected a mole (the type) at this area on 2 June, 1979.

Three mammalian species other than the mole have been reported from Uotsuri-jima (Shiraishi & Arai, 1980): *Apodemus agrarius*, *Rattus rattus*, and introduced domestic goats (one adult pair and their two offspring sighted in May, 1979). *A. agrarius* in Uotsuri-jima is larger in many dimensions of the skull than those from Taiwan and Cheju (Korea) and retains an excess B chromosome (2n =49) compared with that (2n=48) of the mice from Taiwan (Shiraishi & Arai, 1980). According to a tentative experiment by Dr. K. Tsuchiya (the Hokkaido

Institute of Public Health at the time of the experiment), interbreeding between *A. agrarius* from this island and that from Taiwan is possible. Thus, the mouse from Uotsuri-jima appears to be less differentiated as compared with the mole. The reason for this difference is not known, but one possible explanation is that the mouse is a later immigrant. In this case it probably invaded the island by some unknown methods during the approach, due to the retreat of the sea, of the Continent to the island in the last glacial age (Würm) or by some human agents in later ages. This problem, however, is subjected to the future study.

Moles are animals of temperate and subfrigid zones and usually are scarce in subtropical or tropical environments because of their burrowing habits and the peculiar physiological constraint as a group of Insectivora (McNab, 1979). When they are in geographical tropics, they usually occur at high altitudes as shown by *E. micrura* in the Malay Peninsula. The occurrence of *N. uchidai* in a subtropical island, Uotsuri-jima, is unique for the moles. This situation has been probably achieved under the isolated island with a simple mammalian fauna.

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